

Helping Students Understand the Nature of Science

By Deborah L. Hanuscin and Eun J. Lee

"I keep coming across lessons and articles related to teaching students about the nature of science—what exactly does that mean? How can I help my students learn about the nature of science?"

What is meant by the "nature of science," and why is this important for students to learn?

Teachers help students develop process skills and inquiry abilities, as well as understand facts, concepts, and principles in science. A third goal of science teaching is helping students understand the "nature of science"—what science is and how science works. The nature of science addresses the importance of creativity and imagination in scientific work; how scientists invent explanations for phenomena; the difference between observation and inference; how scientific ideas are subject to change; and how culture and society influence science. The National Science Education Standards (Content Standard G) emphasize that students should understand the power and limitations of science, the use of scientific knowledge in decision making, and science as an important part of culture (NRC 1996). By focusing on not just what we know but how we know, teachers are providing students with a robust view of science.

What does the research say about students' ideas about the nature of science?

Students' ideas about science are informed by media images of science and scientists and are also affected by their school science experiences. Researchers have found that these experiences can result in the formation of myths and misconceptions about the nature of science. For example, Akerson and Abd-El-Khalick (2005) interviewed fourth-grade students who believed that their textbooks contain unchanging scientific truth and that science has little room for creativity because it is a straightforward procedure. Students also believed that science is based solely on what can be observed directly.

Similarly, Driver and colleagues (1996) learned through interviews with nine-year-olds that students had difficulty differentiating between evidence and explanation and failed to recognize the importance of inference to scientific work. Conley and colleagues (2004) asked fifth-grade students to respond to a series of questions about the source, certainty, development, and justification of scientific ideas. Students were likely to view the most important part of science as coming up with the "right" answer and thought scientists know everything about science already. Students' beliefs about science were not related to gender and ethnicity; however, low-achieving and low socioeconomic status students exhibited less sophisticated beliefs about the nature of science than their peers, which could be related to their opportunities to learn science.

What does research say about teaching the nature of science?

Teaching science by modeling how scientists do science is not enough—researchers have shown that the nature of science must be a purposeful and explicit part of classroom lessons and discussions for students to develop their understanding. For example, Akerson and Abd-El-Khalick found that, despite immersion in inquiry-based instruction, fourth graders failed to develop an understanding of the tentative nature of science, instead claiming that the information in science textbooks is "not going to change because science doesn't change" (2005, p. 7). Khishfe and Abd-El-Khalick (2002) examined the development of sixth-grade students' understanding of the nature of science by comparing instruction in two cases: one in which the teacher introduced various ideas about the nature of science, then had students reflect on their ideas about science in the context of inquiry-based lessons, and one in which the nature of science was not an explicit part of classroom discussions. Students in the class where the nature of science was addressed explicitly demonstrated more substantial improvement in their

understanding than the second group. Similarly, Akerson and Volrich (2006) found that when teachers emphasized the role of creativity in scientific work and the way in which scientific ideas are subject to change in light of new evidence, students improved their understanding. At the beginning of the study, the majority of Volrich's first graders believed that scientists do not change their ideas because once they figure out something, science is "done." In response to students' ideas, Volrich pointed out examples of how students changed their ideas during their investigations and concluded her lessons by raising the question, "How is what we did like what scientists do?" At the conclusion of her instruction, her students were able to explain that scientists can change their explanations and ideas because of new evidence.

How can I help my students learn about the nature of science?

As with any topic, to teach the nature of science, teachers must understand the content themselves, know what is important to teach, find out students' incoming ideas, and implement instructional activities and assessments to help students learn. *Science for All Americans* (AAAS 1990) can be a starting point for teachers to learn about the nature of science. Teachers can examine national and state standards to see what ideas about the nature of science are important to teach at their grade levels. Formative assessment probes (Keeley, Eberle, and Dorsey 2008) can help teachers diagnose students' incoming ideas about the nature of science, and example lessons (Bell 2008) can help teachers teach the nature of science. Regardless of the curriculum, it is important to remember that every lesson portrays an image of science to students and conveys information about what science is and how science works. To make the nature of science an explicit part of instruction, ideas about science should be planned for, taught, and assessed intentionally. Teachers can

- invite students to express their own ideas about science and scientists through talking, writing, and drawing;
- help students critically evaluate popular images of science and scientists;
- introduce students to "behind the scenes" information about how the scientific ideas in their textbooks came about;

- encourage students to reflect on their ideas about the nature of science and how these ideas are illustrated by their own classroom science investigations; and
- invite students to consider specific ideas about the nature of science during instruction by asking questions such as, What might cause scientists to change their ideas? or How do you think scientists determined what dinosaurs looked like if they only had the bones?

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